As an initial matter, the specification has been thoroughly checked and corrected, including the typographical error noted by the Examiner on page 2, line 5. It is respectfully requested that the objection to the specification be withdrawn.

Applicants claim a substrate strip, comprising: a frame having a pair of parallel supporting bars; and at least one substrate supported on the supporting bars, the substrate being linked to the supporting bars by only one or two tie bars, for preventing warpage of the substrate due to thermal stress encountered during high-temperature fabrication steps.

For example, as shown in FIGS. 2A and 2B, the substrate 110 of the Applicants' invention is linked to supporting bars 121 and 122 by means of only two tie bars 131 and 132, respectively. During high-temperature fabrication, the substrate expands in the direction of the arrows in FIG. 2B, and since no tie bars are provided in the upper-right and lower-right corners, the substrate 110 can expand freely toward these corners, thus relieving the thermal stresses thereon. In FIGS. 5A and 5B, only one tie bar 431 is provided, thereby permitting thermal expansion toward the other corners.

The above-described substrate strip structures can provide significant benefits over the prior art. In prior art structures, a substrate is linked to supporting bars by four tie bars at four corners of the substrate, such that under high-temperature conditions, the substrate does not freely expand toward the corners thereof, making thermal stresses concentrate toward the center of the substrate and warp the substrate. The Applicants' invention is limited to only one or two tie bars, which enables the substrate to thermally expand without warpage, as explained above, so that a subsequently implanted ball grid array can maintain high coplanarity.

Claim 1 (and apparently also claims 2-6 and 9-13) were rejected under 35 USC 103(a) as being unpatentable over "admitted prior art" in view of U.S. Patent 5,925,934 to Lim. Claims 7, 8, and 14-16 were rejected under 35 USC 103(a) as being unpatentable over "admitted prior art" in view of U.S. Patent 5,847,446 to Park et al. (hereinafter "Park"). These rejections are respectfully traversed.

Lim fails to teach or suggest a substrate strip having only two "tie bars," as defined in the Applicants' invention for preventing substrate warpage. With reference to FIG. 11 of Lim, as cited in the Office Action, a chip-sized package (CSP) includes a chip 505 that is held in a cavity 575 of a frame 570 by a pair of frame tie-bars 530 (see column 7, lines 21-24). The tie-bars 530 extend into opposite sides of the cavity 575 for supporting the chip 505 in the cavity 575. Additional tie-bars can be provided for ensuring stability of the chip 505 "during handling, and especially during the encapsulation process" (column 7, lines 25-26). Therefore, the tie-bars taught by Lim are provided for supporting and holding the chip in position during fabrication, and do not correspond to the Applicants' claimed "tie bars", which prevent warpage of the substrate.

With reference to claims 7, 8, and 14-16, Park fails to teach or suggest a substrate strip having just one "tie bar," as defined in the Applicants' invention for preventing substrate warpage. Park discloses a semiconductor package with a chip attach pad 120 having at least one slot 124 formed in a perimeter region thereof (see column 3, lines 32-35). When a semiconductor chip 110 is bonded to the chip attach pad 120, lower surface edges of the chip are located along the slot and exposed through the slot, such that a molding compound 160 is contained within the slot and adhered to the lower edges of the chip, in order to prevent delamination or cracks from occurring (see column 3, line 56 to column 4, line 5). As shown in FIG. 5, the chip attach pad 120 is joined with at least one tie-bar 122, which "provides the chip attach pad 120 with a mechanical stability" (column 4, lines 24-25). Therefore, the tie-bar 122 in Park is provided only for supporting and holding the chip attach pad 120 in place, and does not correspond to Applicants' claimed "tie bar", which prevents warpage of the substrate.

For the above-cited reasons, Lim or Park, whether each reference is taken alone or in combination with the prior art, do not anticipate or otherwise render obvious the Applicants' claimed invention.

It is believed the application is in condition for immediate allowance, which action is earnestly solicited.

Respectfully submitted,

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APPENDIX A:
VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

The paragraph on page 1, lines 11-16 has been amended as follows:

BGA (Ball Grid Array) is an advanced type of semiconductor packaging technology which is characterized in the use of a substrate whose front side is used for the mounting of a semiconductor chip thereon, and whose back side is implanted with a grid array of solder balls. During a SMT (Surface Mount Technology) process, the BGA package can be mechanically bonded and electrically coupled to an external printed circuit board (PCB) by means of these solder balls.

The paragraph on page 1, lines 17-25 has been amended as follows:

Conventionally, BGA packages are fabricated in batch on a substrate strip composed of a series of substrates. One problem of the conventional substrate strip structure, however, is that each substrate thereon would easily suffer from thermally-stressed warpage during high-temperature fabrication steps, such as during die-bond cure, wire bonding, molding, and molding cure, during which the temperature is typically about 200°C. The warped substrate would then cause an uncoplanarity problem to the subsequently implanted solder balls on the back side thereof, which would adversely affect the quality of the subsequent mounting of the BGA packages on external printed circuit boards (PCB). This thermally-stressed warpage problem is illustratively depicted in the following with reference to FIGs. 1A-1D.

The paragraph on page 2, lines 1-8 has been amended as follows:

FIG. 1A is a schematic diagram showing a sectional view of a typical BGA package. As shown, the BGA package is constructed on a substrate 11 whose front side 11a is mounted with a semiconductor chip 20 and whose back side 11b is implanted with a grid array of solder balls

(i.e., ball grid array) 30. The semiconductor chip 20 can be electrically coupled to the substrate [10] 11 by means of the well-known wire-bonding technology or flip-chip technology. During a subsequent SMT (Surface Mount Technology) process, the BGA package can be mechanically bonded and electrically coupled to an external printed circuit board (PCB) 40 by means of the ball grid array 30.

The paragraph on page 2, lines 9-17 has been amended as follows:

Referring further to FIG. 1B, in [factory] fact, BGA fabrication is typically implemented in batch on a substrate strip 10 which is composed of a series of substrates 11 supported on a frame 12 having a pair of parallel elongated supporting bars 12a, 12b. Each of the substrates 11 is used for the fabrication of an individual unit of a BGA package. Conventionally, each of the substrates 11 is rectangularly-shaped and linked to the supporting bars 12a, 12b by means of a four-point linkage structure consisting of four tie bars 13a, 13b, 13c, 13d on the four corners thereof. Typically, the upper-left tie bar 13a is also used to provide a gate (not shown) which is used for the injection of encapsulant during the fabrication of an encapsulation body (not shown) for [encapsulate] encapsulating the semiconductor chip 20.

The paragraph on page 3, lines 1-5 has been amended as follows:

As further shown in FIG. 1D, when the thermally-warped substrate 11 is implanted with the ball grid array 30, it would cause the implanted ball grid array 30 to have poor coplanarity. During the subsequent SMT process, this BGA uncoplanarity would cause some solder balls in the ball grid array 30 to be unreliably bonded to the PCB 40, thus resulting in a reliability problem [to] in the BGA package.

The paragraph on page 3, lines 15-23 has been amended as follows:

The U.S. Patent No. 5,652,185 discloses an inventive method of packaging a BGA assembly with a substrate that has been formed from a substrate strip whose area has been maximized.

The U.S. Patent No. 5,635,671 discloses a package assembly constructed on a substrate with a novel degating region to allow removal of excess encapsulant formed on the substrate surface during molding without damaging the remainder of the device. The U.S. Patent No. 5,691,242 discloses an advanced method for packaging an integrated circuit on an organic substrate. All of these patents, however, [utilizes] utilize a substrate strip with the above-mentioned four-point linkage structure, so that the above-mentioned warpage problem during high-temperature fabrication steps still exists.

The paragraph on page 4, lines 5-12 has been amended as follows:

The substrate strip of the invention is characterized by the provision of a warpage-preventive linkage structure, by which each substrate on the substrate strip is supported by means of no more than two tie bars, i.e., either by a two-point linkage structure or a one-point linkage structure, in contrast to the four-point linkage structure utilized by the prior art. During high-temperature fabrication steps when the substrate is subjected to thermal stresses, the substrate can freely [expanded] expand toward the corners where no tie bars are provided; and consequently, it can be unwarped by the thermal stresses. This unwarped substrate allows the subsequently implanted ball grid array thereon to have high coplanarity.

The paragraph on page 6, lines 9-17 has been amended as follows:

FIG. 2B is a schematic diagram used to depict the thermal expansion of each substrate 110 during high-temperature fabrication steps. Under the high-temperature conditions, the substrate 110 would normally [expanded] expand outwards in all directions. However, as illustrated in FIG. 2B, since the upper-left and bottom-left corners of the substrate 110 are provided with the tie bars 131, 132, the thermal expansion would be retarded in these directions; and since no tie bars are provided on the upper-right and bottom-right corners, the substrate 110 can freely expand toward these corners, thus relieving the thermal stresses thereon. As a result, the substrate 110 [would be] is unlikely to become warped during the high temperature fabrication steps.

The paragraph on page 9, lines 6-9 has been amended as follows:

Through actual on-site tests, it is found that the invention can significantly help [to] improve the coplanarity of the ball grid array implanted on the back side of the substrate by providing an unwarped substrate. One example of the test data is shown in the following table (the data represent the measured distance between the ball grid array and reference plane).

IN THE ABSTRACT

The abstract has been amended as follows:

A substrate strip with warpage-preventive linkage structure is proposed for a BGA (Ball Grid Array) application. The proposed substrate strip is composed of a series of substrates, each being used for the construction of an individual unit of a BGA package, and which is characterized by the provision of a warpage-preventive linkage structure, by which each substrate on the substrate strip is supported by means of no more than two tie bars, i.e., either by a two-point linkage structure or a one-point linkage structure, in contrast to the four-point linkage structure utilized by the prior art. During high-temperature fabrication steps when the substrate is subjected to thermal stresses, the substrate can freely [expanded] expand toward the corners where no tie bars are provided; and consequently, it can be unwarped by the thermal stresses. This unwarped substrate allows the subsequently implanted ball grid array thereon to have high coplanarity.

IN THE CLAIMS

Claims 9 and 14 have been amended as follows:

9. (Amended) A substrate strip, which comprises:

(a) a frame having a pair of parallel supporting bars including a first supporting bar and a second supporting bar; and

(b) at least one [substrates] substrate supported on the supporting bars[;], the substrate being linked to the supporting bars by means of a two-point linkage structure consisting of just two tie bars linked to the supporting bars.

14. (Amended) A substrate strip, which comprises:

(a) a frame having a pair of parallel supporting bars including a first supporting bar and a second supporting bar; and

(b) at least one [substrates] substrate supported on the supporting bars[;], the substrate being linked to the supporting bars by means of a one-point linkage structure consisting of just one tie bar linked to one of the two supporting bars.